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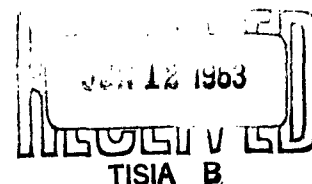
Report No. 8926-151

Material - Aluminum - 7075-T6

Effect of Fatigue Loading on Unhealed Porosity Void Growth

D. H. Love, G. D. Lindeneau, W. E. Wise

21 September 1959



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REPORT NO.

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Effect of Fatigue Loading on Unhealed Porosity Void Growth

Abstract:

Test specimens taken from 7075-T6 aluminum alloy forgings were chosen with voids (unhealed porosity) situated at the surface and center of test sections and fatigue tested at 20,000 psi gross stress in axial tension at a stress ratio of 0.05. Ultragraph recordings of void size were made throughout to note growth as fatigue stressing progressed. The test observations indicated that internal voids which did not emerge to specimen surfaces exerted little or no effect on fatigue life; however, those voids which appeared at specimen surfaces caused appreciable reductions in fatigue life.

Reference: Love, D. H., Lindeneau, G. D., Wise, W. E.,
"Void Growth In 7075-T6 Aluminum Forgings,"
General Dynamics/Convair, Report SL59-092,
San Diego, California, 21 September 1959
(Reference Attached).

SAN DIEGO

STRUCTURES & MATERIALS LABORATORIES

REPORT SL59-092

DATE 21 September 1959

MODEL F-102A

TITLE

REPORT NO. SL59-092
VOID GROWTH IN 7075-T6
ALUMINUM FORGINGS
MODEL F-102A

CONTRACT NO. AF 33(600)-33695

PREPARED BY D. H. Love

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Chief of Structures and
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WITNESS :

NO. OF PAGES 6

L. V. Clements - Structures

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ANALYSIS

PREPARED BY D. H. Love

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REPORT NO. SL59-092

MODEL F-102A

DATE 21 September 1959

TEST PROCEDURE:

The test specimens were subjected alternately to the ultrasonic examinations and to 20,000 PSI fatigue loading with an $R = .05$.

Small numbers of cycles were applied to the specimens on the first testing sequence. When the subsequent ultrasonic examination showed no changes, the numbers of cycles were increased. When there were apparent void growths, small numbers of cycles were scheduled in an attempt to increase the size of the void again without failing the specimen.

A total of six ultrasonic examinations were made. The first was used to locate the test specimens within the original blocks. The other five examinations were conducted after various numbers of cycles of fatigue loading. After the sixth examination, the specimens were run to failure to establish a frame of reference.

The ultrasonic (Ultragraph) process involves a crystal focused ultrasonic beam traversing the specimen. A flat surface, such as a void, reflects the beam while the normal material does not. Each traverse is "painted" on an oscilloscope screen. A photograph is taken by means of time exposure while the beam makes a series of traverses covering the whole specimen (Figure 2).

Fatigue testing was done in a Sonntag SF-10 universal fatigue machine at 1,800 cycles per minute with a 5:1 load amplifier. The fatigue test set up is shown in Figure 3.

TEST RESULTS AND DISCUSSION:

The complete test results are listed in Table I.

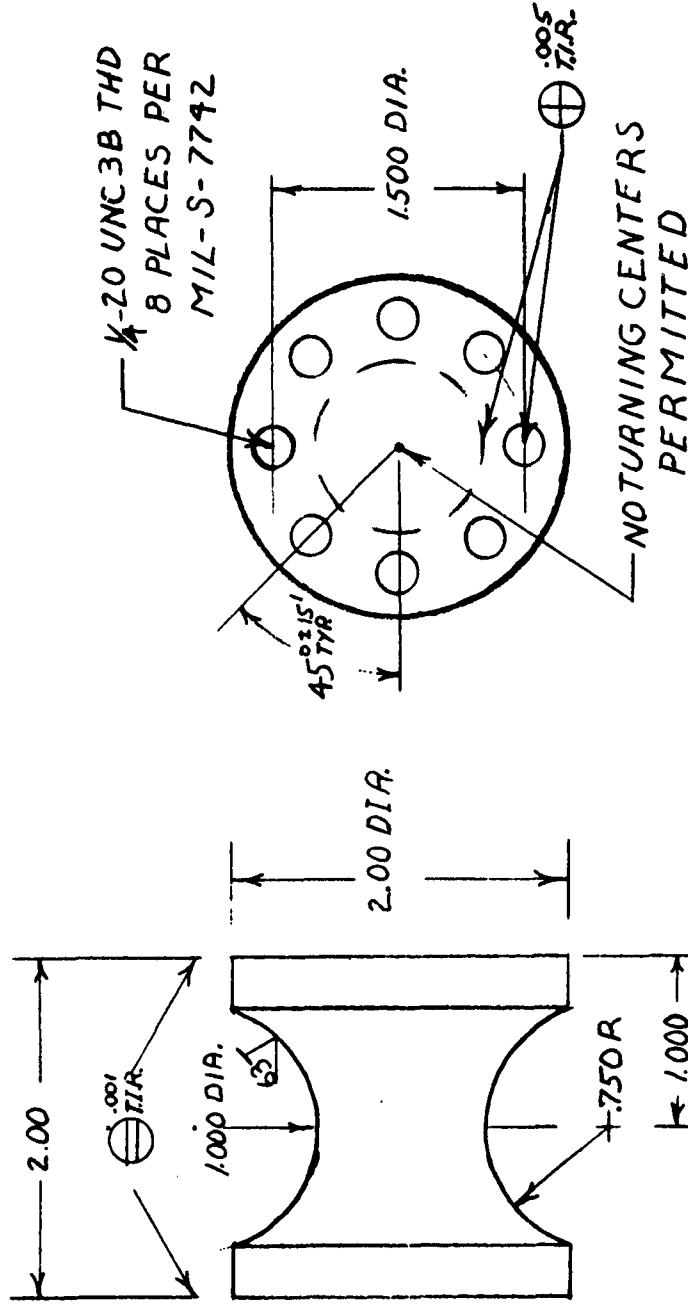
Table I includes the interpretation of the ultragraph photos under "Void Growth".

The interpretation of these photos over several different examinations depends on uniform specimen orientation, uniform instrument sensitivity, and uniform photographic processing.

In cases where the above requirements were not met, the voids would seem to have grown or healed depending on the process variations. However, in most of the shorter life specimens, a void extension or a new void was detected shortly before failure.

NOTE:

The data from which this report was prepared are recorded in Structures Test Laboratory Data Book No. 4057, pages 95 through 107.



NOTES:

1. \ominus INDICATE SURFACES THAT MUST BE PARALLEL
 $\&$ CONCENTRIC RESPECTIVELY WITHIN SPECIFIED
 TOTAL INDICATOR READING
2. ALL SURFACES ∇ EXCEPT AS NOTED
3. STANDARD CONVAIR DWG. TOLERANCES TO APPLY
 UNLESS OTHERWISE SPECIFIED

STRUCTURAL TEST
 CONVAIR - SAN DIEGO
 A DIVISION OF GENERAL DYNAMICS

TITLE

TEST SPECIMEN

MODEL	SCALE	DATE	DRAWN BY
F-102	FULL	9/29/59	A.W. CLARK
SO	DRAWING NUMBER		
WO	FIGURE - 1		

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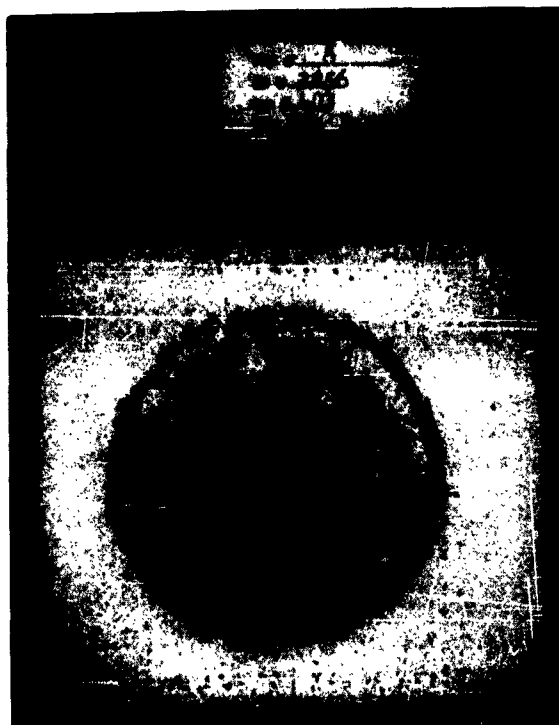


Figure 2 ULTRAGRAPH OF SPECIMEN 13

Void is in the white area at the center of the black circle. The 8 white areas around the edge of the black area are attachment holes.

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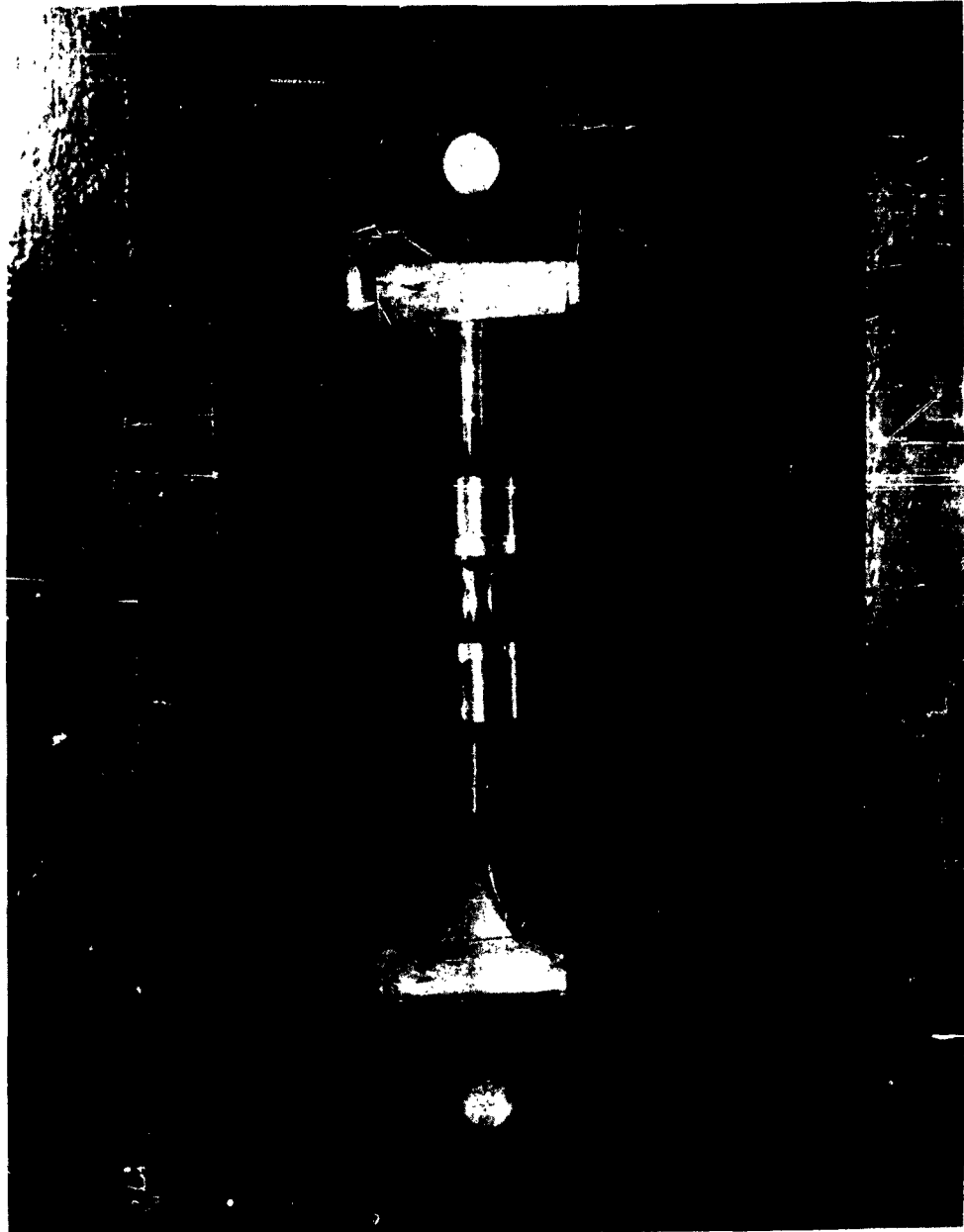


Figure 3 FATIGUE TEST SET-UP

TABLE I
COMPLETE TEST RESULTS

SPECIMEN NO.	CODE NO.	TYPE	MAX GROSS STRESS	STRESS RATIO	CYCLES APPLIED	VOID GROWTH	CYCLES APPLIED	VOID GROWTH	TOTAL CYCLES	VOID GROWTH	CYCLES APPLIED	VOID GROWTH	TOTAL CYCLES	VOID GROWTH	CYCLES APPLIED	VOID GROWTH	TOTAL CYCLES	VOID GROWTH	FAILURE LOCATION	
1	301	A	20,000	.05	5,000	↑	10,000	15,000	↑	20,000	35,000	NO	40,000	75,000	NO	100,000	175,000	21,000	OV	
2	402	I	↓	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	100,000	175,000	13,000	E	
3	1D1	V														100,000	175,000	11,000	NV	
4	2D2	A														100,000	175,000	57,000	F	
5	4D1	B														73,000	148,000	168,000	NV	
6	4H2	A														100,000	175,000	105,000	NV	
7	1S2	I														100,000	175,000	151,000	F	
8	2D3	I														100,000	175,000	98,000	OV	
9	3D4	I														100,000	175,000	37,000	NV	
10	3D5	I														100,000	175,000	69,000	F	
11	3D2	I			5000		20,000	15,000	↑	40,000	60,000	YES	27,000	87,000	FAILED			81,000	NV	
12	2D1	I			10,000		↑	↑	↑	↑	↑	YES	21,000	81,000	FAILED			81,000	NV	
13	1D3	I			↑		↑	↑	↑	↑	↑	NO	40,000	100,000	NO	100,000	200,000	27,000	F	
14	1D2	I			↑		↑	↑	↑	↑	↑	YES	10,000	70,000	FAILED			70,000	OV	
15	3D3	B			10,000		40,000	60,000	↑	100,000	100,000	NO	40,000	100,000	NO	100,000	200,000	121,000	F	
16	4H4	C			5,000		20,000	15,000	↑	↑	↑	↑	↑	↑	↑	↑	↑	85,000	↑	
17	4H1	A			↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	72,000	↑	
18	4H5	V			↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	108,000	↑	
19	4H3	C			↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	67,000	F	
20	2S1	D			↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	123,000	NV	
21	3S1	I			↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	61,000	F	
22	1S4	I			↑		↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	97,000	F	
23	2S3	I			5000		20,000	15,000	↑	↑	↑	YES	75,000	75,000	YES	4,000	79,000	79,000	NV	
24	1S3	I			10,000		40,000	60,000	↑	↑	↑	NO	100,000	200,000	NO	100,000	300,000	107,000	NV	
25	2S2	I	↓	↑	↑		↑	↑	↑	40,000	100,000	YES	25,000	125,000	YES	25,000	150,000	90,000	NV	
26	3S2	I			↑		↑	↑	↑	32,000	92,000	NO	25,000	117,000	NO	25,000	142,000	94,000	NV	
27	1S1	D	20,000	.05	10,000	NO	10,000	20,000	NO	40,000	60,000	NO	Q	60,000	NO	100,000	160,000	215,000	NC	F
* FAILURE LOCATION CODE :																				
OV ~ ORIGINAL VOID ~ VOID INDICATED IN FIRST ULTRASONIC EXAMINATION																				
NV ~ NEW VOID ~ VOID APPEARED IN SUBSEQUENT EXAMINATIONS																				
NAN ~ NO APPARENT VOID ~ NO VOID FOUND IN ANY OF THE ELIMINATIONS																				
F ~ END OF SPECIMEN ~ THROUGH AND ADJACENT TO THE ATTACHMENT SCREWS																				
NOTE :																				
IN THOSE CASES WHERE FAILURE OCCURRED AT THE ORIGINAL VOID (SPECIMENS 1, 8, AND 19), THE ORIGINAL VOID WAS ADJACENT TO THE SURFACE																				